

Standard Specifications for the Design and Fabrication of

STRUCTURAL GLUED LAMINATED LUMBER

1951

(REVISED 1953)



DOUGLAS FIR

WEST COAST HEMLOCK



SITKA SPRUCE

WESTERN RED CEDAR

WEST COAST LUMBERMEN'S ASSOCIATION

1410 S. W. MORRISON STREET

PORTLAND 5, OREGON

FOREWORD

Acknowledgment is made to the Forest Products Laboratory, Forest Service, United States Department of Agriculture, Madison, Wisconsin, for basic data furnished and for assistance in preparing these standard specifications. These standard specifications conform to the principles recommended by the Forest Products Laboratory and are based on the most recent research and technical experience available.

The commercial grades of Douglas fir lumber listed in the stress tables were the subject of a special study as relating to their use in structural glued laminated lumber and the working stresses are the result of a statistical analysis of this study.

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PART ONE

STANDARD SPECIFICATION FOR THE DESIGN

OF

STRUCTURAL GLUED LAMINATED LUMBER

I. GENERAL

A. Structural Glued Laminated Lumber

1. Structural glued laminated lumber is any member comprising an assembly of wood laminations in which the grain of all laminations is approximately parallel longitudinally and in which the laminations are bonded with adhesives.
2. Laminations shall be arranged horizontally, (wide face of laminations placed normal to the direction of load), in members stressed principally in bending, except as hereinafter provided.

B. Design Formulas

1. Glued laminated members shall be designed by the engineering formulas used for solid sawn wood members and as hereinafter specified.

C. Fastenings

1. The same allowable loads, stresses and methods of design for bolts, connectors and other fastenings apply to glued laminated members as to solid sawn members.

D. Standard Sizes

1. Standard sizes of glued laminated members shall be as specified in Part Two, Section III.

II. LUMBER GRADES FOR INDIVIDUAL LAMINATIONS

A. Standard Grading and Dressing Rules

1. All lumber shall be graded in accordance with the current Standard Grading and Dressing Rules of the West Coast Lumbermen's Association, (hereinafter referred to as the Grading Rules), with the additional requirements as specified herein. Lumber shall be used in accordance with the provisions of Part Two, Section II-A.

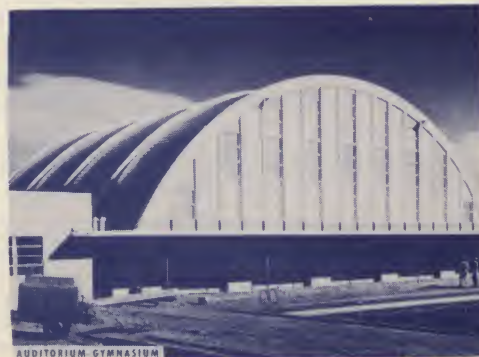
III. DESIGN STRESSES

A. General

1. The allowable unit stresses in Table 1 and Table 2, for structural glued laminated lumber, are applicable to all normal conditions of loading. Specific modifications are indicated hereinafter for other conditions of loading.
2. The tabulated allowable unit stresses and modifications thereto are also applicable to structural glued laminated lumber that has been pressure impregnated by an approved process and preservative.
3. Working stresses that are more or less than those tabulated may be had by appropriately modifying requirements such as: grade combinations, slope of scarf joints, slope of grain, spacing of joints and any other pertinent provisions of these specifications.

B. Dry Condition of Use

1. Allowable stress values for dry condition of use, (Table 1), shall be applicable for normal loading when the moisture content in service is less than 15 percent, as in most covered structures.



Large Auditorium — Arches of 106 ft. span

C. Wet Condition of Use

1. Allowable stress values for wet condition of use, (Table 2), shall be applicable for normal loading when the moisture content in service is 15 percent or more, as may occur in exterior construction.

D. Modification of Stresses

1. Duration of Load

- a. When a member is fully stressed by maximum design loads for many years, either continuously or cumulatively, use allowable stresses 90 percent of those tabulated.
- b. When the duration of full design load does not exceed the period indicated, increase the tabulated allowable stresses as follows:

15% for 2 months duration
25% for 7 days duration
33⅓% for wind or earthquake
100% for impact

- c. The allowable stress for normal loading may be used without regard to occasional impact if the stress induced by impact does not exceed the allowable stress for normal loading.
- d. The above increases are not cumulative.
- e. Modulus of elasticity is a constant and none of the above adjustments apply.

(Note: For a detailed explanation of modifications of stresses, see National Design Specifications for Stress-Grade Lumber and Its Fastenings.)

2. Curvature Factor

- a. For the curved portion of members, the allowable stress in bending shall be modified by multiplication by the following curvature factor:

$$1 - 2000 \left(\frac{t}{R} \right)^2$$

in which

t=thickness of lamination in inches
R=radius of curvature of a lamination in inches

and t/R shall not exceed $1/125$. No curvature factor shall be applied to stress in the straight portion of an assembly regardless of curvature elsewhere.

3. Radial Tension or Compression

- a. The radial stress induced by a bending moment in a curved member shall be limited to the allowable stress, S_R , when computed by the equation:

$$S_R = \frac{3M}{2Rbh}$$

where

M=bending moment in inch pounds
R=radius of curvature at center line of member in inches
b=width of cross section in inches
h=height of cross section in inches

- b. When M is in the direction tending to decrease curvature, (increase the radius), the stress is in tension and shall be limited to one-third the allowable stress in shear.
- c. When M is in the direction tending to increase curvature, (decrease radius), the stress is in compression and shall be limited to the allowable stress in compression perpendicular to the grain.



Erecting laminated barn rafters

IV. CRITERIA

A. Mixed Grades

1. All laminations shall be the same thickness except as provided in Part Two Section II-A-7.
2. Clear outer laminations shall meet the requirements of Part Two, Section II-A-3.

B. Slope of Grain

1. The slope of grain requirements of Part Two, Section II-A-2 shall be complied with.

C. End Joints, General

1. When all end joints in a member are plain scarf joints and the scarfs are accurately fitted and properly glued, no reduction in moment of inertia or effective cross section need be made.
2. Stepped scarf joints may be used the same as plain scarf joints except the portion of the thickness of the lamination occupied by the step is disregarded in computing the moment of inertia, and/or the net effective area.
3. Spacing of end joints shall be as specified in Part Two, Section IV-B.

D. End Joints, Member Stressed Principally in Bending

1. Compression portion of cross section

- a. No modification of moment of inertia or working stress need be made for glued plain scarf joints having a slope not steeper than 1 in 5.
- b. Butt joints may be used in the compression portion of the cross section providing that all laminations at a single cross section having such joints are disregarded in computing the moment of inertia. Butt joints in adjacent laminations shall be spaced at least ten times the lamination thickness.

2. Tension Portion of Cross Section

- a. The slope of scarf joints, in the tension portion of a member shall be governed by the allowable bending stress as follows:

Dry Condition of Use	Slope of Scarf	Wet Condition of use	Slope of Scarf
2600 p.s.i. and over	1:12	2000 p.s.i. and over	1:12
Under 2600 p.s.i.	1:8	Under 2000 p.s.i.	1:8

Butt joints may be used as hereinafter specified.

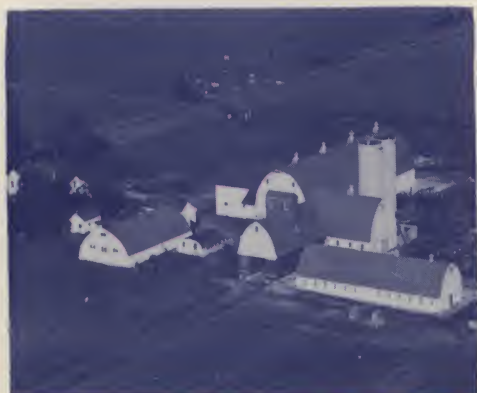
- b. Butt joints may be used in the tension portion of the cross section, in which case, the effective moment of inertia shall be computed by subtracting from the moment of inertia of the full cross section, 1.2 times the sum of the moments of inertia of those laminations containing butt joints at a single cross section. Butt joints in adjacent laminations shall be spaced at least ten times the lamination thickness.

E. End Joints, Curved Section

1. In members curved to a radius less than 250 times the thickness of a lamination in the portion of laminations stressed to more than 60 percent of allowable working stresses, scarfed end joints shall be required in the compression as well as tension portion of the cross section.

F. End Joints, Compression Members

1. Scarf joints shall not be steeper than 1 in 5 and no reduction in area need be made for plain scarf joints.
2. Butt joints may be used in compression members, in which case the effective cross-sectional area shall be computed by subtracting from the gross cross-sectional area, the area of all laminations containing butt joints at a single cross section. In addition, laminations adjacent to those containing butt joints and themselves containing



Laminated rafters in all types of farm structures



Architectural treatment — Club portico



Unusual designs — College theatre

butt joints, shall be considered only partially effective if the spacing in adjacent laminations is less than 50 times the lamination thickness. The effective area of such adjacent laminations shall be computed by multiplying their gross area by the following percentages:

Butt joint spacing (t = lamination thickness)	Effectiveness factor (Percent)
30 t	90
20 t	80
10 t	60

Butt joints in adjacent laminations shall be spaced at least ten times the lamination thickness.

G. End Joints, Tension Members

1. The slope of scarf joints in all laminations of a member stressed principally in axial tension shall be governed by the allowable fiber stress as follows:

Dry Condition of Use	Slope of Scarf	Wet Condition of Use	Slope of Scarf
2600 p.s.i. and over	1:12	2000 p.s.i. and over	1:12
Under 2600 p.s.i.	1:10	Under 2000 p.s.i.	1:10

V. VERTICALLY LAMINATED BEAM (Member stressed principally in bending)

A. Design Stresses

1. The allowable stresses for a vertically laminated beam shall be as specified in the Grading Rules for the grade of material used.
2. Allowable stresses for vertically laminated beams made of combination grades shall be the weighted average of the grades.

B. End Joints

1. All end joints shall be scarfed to a slope not steeper than 1 in 8.

C. Edge Joints

1. A lamination made up of two or more pieces shall be edge glued.

PART TWO

STANDARD SPECIFICATION FOR THE FABRICATION OF STRUCTURAL GLUED LAMINATED LUMBER

I. GENERAL PROVISIONS

A. Workmanship

1. Fabrication shall be in accordance with the best practices, with adequate plant and equipment, and under the supervision of properly qualified personnel.

B. Laminations

1. This specification is predicated on individual laminations being of 2 inches net or less in thickness.

II. MATERIAL

A. Lumber

1. General Requirements

- a. The lumber used shall be uniformly manufactured and shall be of the grade or grades required by the stress tables except when modified hereinafter.
- b. Each lamination shall be graded in relation to the end use size of the member.
- c. When lumber to be used for laminating is resawn, the new size shall meet the grade requirements.

2. Slope of Grain

- a. All slope of grain requirements shall be applied to the full length of the piece. Local slope of grain deviation shall be disregarded.
- b. Members stressed principally in bending
 1. The slope of grain requirements of the laminations used in the top and bottom 10 per cent of a member stressed principally in bending are as follows:

Dry Condition of Use	Slope of Grain	Wet Condition of Use	Slope of Grain
2600 p.s.i. and over	1:18	2000 p.s.i. and over	1:18
2400 p.s.i.	1:16	1800 p.s.i.	1:14
2200 p.s.i.	1:14	1600 p.s.i.	1:12
2000 p.s.i.	1:12		

c. Members stressed principally in axial tension.

1. The slope of grain requirements of all laminations of a member stressed principally in axial tension are as follows:



Economical School Buildings

Dry Condition of Use	Slope of Grain
2600 p.s.i. and over	1:18
2400 p.s.i.	1:16
2200 p.s.i.	1:14
2000 p.s.i.	1:12

Wet Condition of Use	Slope of Grain
2000 p.s.i. and over	1:18
1800 p.s.i.	1:14
1600 p.s.i.	1:12

ALLOWABLE UNIT STRESSES—STRUCTURAL GLASS

Allowable unit stresses are for

Allowable unit stresses are

TABLE 1—DRY CO

Combination Number	Grade Combinations			Extreme in Bending
	1	2	3	4
	Grade of laminations at top and bottom	Number at top and at bottom	Grade of inner laminations	From 4 to 14 laminations
1	Clear (Dense) *	One	Dense Select Structural	3000
2	Clear (Dense) *	One	Dense No. 1	3000
3	Dense Select Structural	All	Dense Select Structural	2800
4	Clear (Close-Grain) *	One	Select Structural	2800
5	Select Structural	All	Select Structural	2600
6	Select Structural	1/5 of total	No. 1	2600
7	Clear (Medium Grain) *	One	No. 1	2600
8	Dense No. 1	All	Dense No. 1	2400
9	Dense No. 1	1/14 of total	No. 1	2400
10	Select Structural	One	No. 1	2400
11	Select Structural	1/5 of total	No. 2	2200
12	Clear (Medium Grain) *	One	No. 2	2200
13	Select Structural	One	No. 2	2200
14	No. 1	All	No. 1	2000
15	No. 1	One	No. 2	2000
16	No. 2	All	No. 2	1600

Modulus of elasticity, dry conditions of use, 1,800,000

TABLE 2—WET CO

1	Clear (Dense) *	One	Dense Select Structural	2400
2	Clear (Dense) *	One	Dense No. 1	2400
3	Dense Select Structural	All	Dense Select Structural	2200
4	Clear (Close-Grain) *	One	Select Structural	2200
5	Select Structural	All	Select Structural	2000
6	Select Structural	1/5 of total	No. 1	2000
7	Clear (Medium Grain) *	One	No. 1	2000
8	Dense No. 1	All	Dense No. 1	2000
9	Dense No. 1	1/14 of total	No. 1	2000
10	Select Structural	One	No. 1	2000
11	Select Structural	1/5 of total	No. 2	1800
12	Clear (Medium Grain) *	One	No. 2	1800
13	Select Structural	One	No. 2	1800
14	No. 1	All	No. 1	1600
15	No. 1	One	No. 2	1600
16	No. 2	All	No. 2	1200

Modulus of elasticity, wet conditions of use, 1,600,000

* See Part Two, Section II-A-3-a.

SELECTED DOUGLAS FIR, (COAST REGION), LUMBER.

Conditions of loading.
pounds per square inch.

CONDITIONS OF USE.

5	Tension Parallel to Grain "t"		Compression Parallel to Grain "c"		Horizontal Shear "H"	Compression Perpendicular to Grain "c $\perp$ "
	6	7	8	9		
5 or more laminations	From 4 to 14 laminations	15 or more laminations	From 4 to 14 laminations	15 or more laminations		
3000	3000	3000	2400	2500	165	455
3000	2600	3000	2200	2300	165	455
3000	3000	3000	2400	2500	165	455
2800	2800	2800	2200	2200	165	415
2800	2800	2800	2200	2200	165	415
2800	2400	2600	2000	2000	165	415
2600	2200	2400	1900	2000	165	390
2600	2600	3000	2200	2300	165	455
2600	2200	2400	1900	2000	165	455
2600	2200	2400	1900	2000	165	415
2600	2400	2600	1900	2000	165	415
	2000	2400	1800	1900	165	390
	2000	2400	1800	1900	165	415
2200	2200	2400	1900	2000	165	390
2200	2000	2400	1800	1900	165	390
2000	2000	2400	1800	1900	165	390

CONDITIONS OF USE.

2400	2400	2400	1700	1800	145	305
2400	2000	2400	1600	1700	145	305
2400	2400	2400	1700	1800	145	305
2200	2200	2200	1600	1600	145	275
2200	2200	2200	1600	1600	145	275
2200	2000	2000	1400	1500	145	275
2000	1800	2000	1400	1400	145	260
2200	2000	2400	1600	1700	145	305
2200	1800	2000	1400	1400	145	305
2000	1800	2000	1400	1400	145	275
2200	1800	2000	1400	1400	145	275
1800	1600	1800	1300	1400	145	260
1800	1600	1800	1300	1400	145	275
1800	1800	2000	1400	1400	145	260
1800	1600	1800	1300	1400	145	260
	1600	1800	1300	1400	145	260



School Gymnasium with 86 ft. beams

d. Members stressed principally in axial compression.

1. The slope of grain requirements of all laminations of a member stressed principally in axial compression are as follows:

Dry Condition of Use	Slope of Grain
2000 p.s.i. and over	1:15
1900 p.s.i.	1:14
1800 p.s.i.	1:12

Wet Condition of Use	Slope of Grain
1500 p.s.i. and over	1:15
1400 p.s.i.	1:14
1300 p.s.i.	1:12

3. Rate of Growth

- a. The rate of growth and density requirements of inner laminations shall apply to clear outer laminations.

4. Structural Grading of Small Lumber Sizes

- a. Small sizes not customarily graded for structural use shall have the following additional requirements included as part of the grade when used in laminated members.
 1. Boards less than 2" in nominal thickness shall be graded for slope of grain and knot sizes on the wide face in accordance with the grade provisions of comparable joist and plank sizes.
 2. 2"x3" and 2"x4" lumber for use in laminated members and for which there are no grade provisions in Grading Rules providing for bending or tensile values, shall meet the appropriate grade requirements and the following knot size requirements:

Grade	Nominal Width of Face	Knot Size	
		Edge of Wide Face	Center Line of Wide Face
No. 1 or Dense No. 1	3"	3/4"	1"
	4"	1"	1 1/2"
No. 2	3"	1"	1 1/4"
	4"	1 1/4"	1 3/4"

5. Moisture Content

- a. At time of gluing, the lumber shall be conditioned to a moisture content approximating that which it will attain in service, but shall be not less than 7 nor more than 16 percent.
- b. The range of moisture content of various laminations assembled into a single member shall not exceed 5 percent, (for example, 8 to 12, or 10 to 14 percent inclusive), at the time of gluing.

6. Surface Requirements for Laminations

- a. Surfaces of laminations to be glued shall be clean and shall be free from oil, dust and other foreign matter which will be detrimental to satisfactory gluing.
- b. Laminations shall be machine finished, but not sanded, to a smooth surface and to a uniform thickness with a maximum allowable variation of 1/64 of an inch.
- c. Warp, twist, or other characteristics which will prevent intimate contact of adjacent glued faces or interfere with uniform bending to the required curvature when under clamping pressure shall not be permitted.

7. Thickness of Laminations

- a. Stress tables assume laminations of the same uniform thickness. When laminations of differing thicknesses are used, the thickness of the thinner laminations shall be converted to an equivalent number of laminations of uniform thickness, as based on the thickest lamination used.

B. Adhesives

1. General Requirements

- a. Approved adhesives shall be those which have been acceptably certified as performing satisfactorily for the uses hereinafter described and when tested for durability in conformance with the latest available procedure developed by the Forest Products Laboratory of the U. S. Dept. of Agriculture.
- b. Mixing, spreading, storage life, pot life, working life and assembly life shall be in accordance with the manufacturer's recommendations.
- c. Each lot number of adhesive shall be certified as conforming to the applicable specification.



Giant sizes—30 inches square by 85 ft. for dredger spud

2. Interior Use

- a. Water resistant type adhesives shall be used only where the normal moisture equilibrium of the material will be less than 15 percent in use as in interior and protected locations. Such adhesives shall comply with the requirements of the following specifications:
 1. Federal Specification C-G-456 for casein glue.

3. Exterior Use

- a. Exterior type adhesives may be used for any construction, (exterior, submerged or interior), and such adhesives shall comply with the following specifications:
 1. Joint Military Specification MIL-A-397A for room and intermediate temperature setting resin glue of the phenol, resorcinol and melamine type, as amended.
 2. Joint Military Specification MIL-A-5534 for high temperature setting resin glue of the phenol, resorcinol or melamine type, as amended.

III. STANDARD SIZES OF GLUED LAMINATED LUMBER

A. Depth

1. Straight and curved members shall be finished to the depth dimensions required by the design.

B. Width

1. Standard finished widths of laminated members shall be as follows:

Nominal Width	3"	4"	5"	6"	8"	10"	12"	14"	16"
Net Finished Width	2 $\frac{1}{4}$ "	3 $\frac{1}{4}$ "	4 $\frac{1}{4}$ "	5"	7"	9"	11"	12 $\frac{1}{2}$ "	14 $\frac{1}{2}$ "
				5 $\frac{1}{4}$ "					

IV. END JOINTS

A. General Requirements

1. All end joints shall meet the design requirements of Part One, Section IV.
2. Scarf joints shall be accurately fitted and properly glued.
3. Scarf joints with a slope steeper than 1 in 10 shall not be used in members intended for wet condition of use.

B. Spacing of End Joints

1. Members Stressed Principally in Bending

- a. Scarf joints in the tension portion of the cross section shall be well scattered.
- b. Butt joints in adjacent laminations shall not be spaced closer together than 10 times the thickness of the lamination.

2. Members Stressed Principally in Tension

- a. Scarf joints shall be well scattered.

3. Members Stressed Principally in Compression

- a. Butt joints in adjacent laminations shall not be spaced closer together than 10 times the thickness of the lamination.

V. EDGE JOINTS

A. General Requirements

1. For wide members, a lamination may consist of two or more pieces of lumber placed side by side provided that all longitudinal joints in adjacent laminations are staggered at least 2 inches laterally.
2. For exterior use, top and bottom face laminations of a member shall be of one piece in width, or of pieces pre-glued together edgewise.

VI. TAPERED MEMBERS

1. For tapered members, the required slope of grain of the laminations shall be measured with respect to the neutral axis of the member.
2. The above does not apply to that portion of the cross section, not considered in the design of the member, such as usually occurs in built-up haunches.

VII. ASSEMBLY

A. Facilities

1. The fabricator shall provide adequate facilities and equipment so that laminations are prepared, selected, spread, laid up, clamped and set within the adhesive manufacturer's specified time limits.

B. Clamping

1. The clamping time and curing processes required for the setting of adhesives shall be in accordance with the adhesive manufacturer's recommendations.
2. Gluing pressure shall be at least 100 lbs. per square inch and the minimum pressure shall assure close contact of the wood surfaces and provide a uniformly thin glue line. Such relations must be maintained until the adhesive has set.
3. Clamping methods shall be such that the pressure is as uniform as practicable over the whole area.
4. The nailing of laminations in lieu of clamping for pressure shall not be permitted.
5. Clamping may start at any point but shall progress to an end or ends.



Large open areas — 110 ft. arches over swimming pool

VIII. PROTECTION

A. End Sealing

1. An approved end sealer shall be applied after end trimming of each completed member.

B. Protective Coating

1. A wrapping should enclose the completed member when method of shipment warrants protection of finished surfaces.
2. When weather or other conditions dictate, a moisture resistant wrapping or coating should be provided.

IX. IDENTIFICATION AND INSPECTION

A. Identification

1. Each completed member shall bear a specific identification.
2. Where exterior type glue is used, the completed member shall be marked "EXTERIOR."
3. When significant to the proper use of a member that will be stressed principally in bending, the top or bottom face shall be plainly marked.

B. Inspection

1. Inspection, when required, shall be by an approved agency.



Churches of extraordinary beauty with laminated beams and Gothic arches



Flexible design — Theatre with arch roof of varying diameter

REFERENCES

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by T. R. C. Wilson, Forest Products Laboratory, U. S. Department of Agriculture (1939)
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2. *No. D1635. Laminating of Structural Wood Products by Gluing*
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3. *No. R1687. Tests of Glued Laminated Wood Beams and Columns and Development of Principles of Design*
by T. R. C. Wilson and W. S. Cottingham, Forest Products Laboratory, U. S. Department of Agriculture (1947)
Available from the Forest Products Laboratory, Madison 5, Wisconsin.

4. *Miscellaneous Publication No. 185, Guide to the Grading of Structural Timbers and the Determination of Working Stresses*
by T. R. C. Wilson, U. S. Department of Agriculture (1934)
Available only from the National Lumber Manufacturers Association, 1319 Eighteenth Street, N. W. Washington 6, D. C.
5. *No. R1225. Supplement to Miscellaneous Publication No. 185, Guide to the Grading of Structural Timbers and the Determination of Working Stresses*
by T. R. C. Wilson, Forest Products Laboratory, U. S. Department of Agriculture (1940, corrected 1943)
Available from the Forest Products Laboratory, Madison 5, Wisconsin.
6. *No. R1715. Supplement No. 2 to Miscellaneous Publication No. 185, Guide to the Grading of Structural Timbers and the Determination of Working Stresses, Recommendations for Basic Stresses*
Forest Products Laboratory, U. S. Department of Agriculture (1948)
Available from the Forest Products Laboratory, Madison 5, Wisconsin.
7. *Standard Grading and Dressing Rules for Douglas Fir, Sitka Spruce, West Coast Hemlock, Western Red Cedar*
Available from West Coast Lumbermen's Association, 1410 S. W. Morrison St., Portland 5, Oregon.
8. *Federal Specification C-G-456 for Casein Glue*
Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C.
9. *Joint Military Specification MIL-A-397-A and Amendments, for Room and Intermediate Temperature Setting Resin Glue of the Phenol, Resorcinol and Melamine Type*
Available from the Commanding Officer, U. S. Naval Air Station, Technical Records Division, Johnsville, Penn.
10. *Joint Military Specification MIL-A-5534 and Amendments, for High Temperature Setting Resin Glue of the Phenol, Resorcinol and Melamine Type*
Available from the Commanding Officer, U. S. Naval Air Station, Technical Records Division, Johnsville, Penn.
11. *National Design Specifications for Stress Grade Lumber and Its Fastenings*
Available from National Lumber Manufacturers Association, 1319 Eighteenth Street, N. W., Washington 6, D. C.



Large industrial buildings and bangars — 160 ft. crescent trusses, with laminated chords

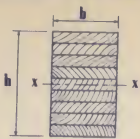
12. *Design Manual for Teco Timber Connector Construction*

Available from Timber Engineering Company, 1319 Eighteenth Street, N. W., Washington 6, D. C.

13. *Fabrication and Design of Glued Laminated Wood Structural Members* (Preliminary)

by A. D. Freas and M. L. Selbo, Forest Products Laboratory, U. S. Department of Agriculture (1952)

Available from the Forest Products Laboratory, Madison 5, Wisconsin.



PROPERTIES OF SECTIONS
GLUED LAMINATED STRUCTURAL LUMBER
1-5/8 Inch Laminations Only
Arranged in order of ascending section modulus.

Nominal Width in Inches	Number of 1 5/8" Laminations*	Net Finished Size* b in Inches h in Inches	Area of Section in Square Inches	Moment of Inertia $I = \frac{bh^3}{12}$	Section Modulus $S = \frac{bh^2}{6}$	Weight in Pounds per Linear Foot at 12% Moisture Content
3	4	2 1/4 x 6 1/2	14.6	51.5	15.8	3.45
4	4	3 1/4 x 6 1/2	21.1	74.4	22.9	4.98
3	5	2 1/4 x 8 7/8	18.3	101.	24.8	4.31
5	4	4 1/4 x 6 1/2	27.6	97.3	29.9	6.52
6	4	5 x 6 1/2	32.5	114.	35.2	7.67
3	6	2 1/4 x 9 3/4	21.9	174.	35.7	5.18
4	5	3 1/4 x 8 7/8	26.4	145.	35.8	6.23
6	4	5 1/4 x 6 1/2	34.1	120.	37.0	8.05
5	5	4 1/4 x 8 7/8	34.5	190.	46.8	8.15
3	7	2 1/4 x 11 3/8	25.6	276.	48.5	6.04
4	6	3 1/4 x 9 3/4	31.7	251.	51.5	7.48
6	5	5 x 8 7/8	40.6	223.	55.0	9.59
6	5	5 1/4 x 8 7/8	42.7	235.	57.8	10.1
5	6	4 1/4 x 9 3/4	41.4	328.	67.3	9.78
4	7	3 1/4 x 11 3/8	37.0	399.	70.1	8.72
8	5	7 x 8 7/8	56.9	313.	77.0	13.4
6	6	5 x 9 3/4	48.8	386.	79.2	11.5
6	6	5 1/4 x 9 3/4	51.2	406.	83.2	12.1
4	8	3 1/4 x 13	42.3	595.	91.6	9.97
5	7	4 1/4 x 11 3/8	48.3	521.	91.7	11.4
6	7	5 x 11 3/8	56.9	613.	108.	13.4
8	6	7 x 9 3/4	68.3	541.	111.	16.1
6	7	5 1/4 x 11 3/8	59.7	644.	113.	14.1
4	9	3 1/4 x 14 7/8	47.5	847.	116.	11.2
5	8	4 1/4 x 13	55.3	778.	120.	13.0
6	8	5 x 13	65.0	915.	141.	15.3
4	10	3 1/4 x 16 1/4	52.8	1,162.	143.	12.5
10	6	9 x 9 3/4	87.8	695.	143.	20.7
6	8	5 1/4 x 13	68.3	961.	148.	16.1
8	7	7 x 11 3/8	79.6	859.	151.	18.8
5	9	4 1/4 x 14 7/8	62.2	1,108.	152.	14.7
6	9	5 x 14 7/8	73.1	1,303.	178.	17.3
5	10	4 1/4 x 16 1/4	69.1	1,520.	187.	16.3
6	9	5 1/4 x 14 7/8	76.8	1,369.	187.	18.1
10	7	9 x 11 3/8	102.	1,104.	194.	24.2
8	8	7 x 13	91.0	1,282.	197.	21.5
6	10	5 x 16 1/4	81.3	1,788.	220.	19.2
5	11	4 1/4 x 17 3/8	76.0	2,023.	226.	17.9
6	10	5 1/4 x 16 1/4	85.3	1,877.	231.	20.1
12	7	11 x 11 3/8	125.	1,349.	237.	29.5
8	9	7 x 14 7/8	102.	1,825.	250.	24.2
10	8	9 x 13	117.	1,648.	254.	27.6
6	11	5 x 17 3/8	89.4	2,380.	266.	21.1
5	12	4 1/4 x 19 1/2	82.9	2,626.	269.	19.6
6	11	5 1/4 x 17 3/8	93.8	2,499.	280.	22.2
8	10	7 x 16 1/4	114.	2,503.	308.	26.8
12	8	11 x 13	143.	2,014.	310.	33.8
5	13	4 1/4 x 21 3/8	89.8	3,339.	316.	21.2
6	12	5 x 19 1/2	97.5	3,090.	317.	23.0
10	9	9 x 14 7/8	132.	2,346.	321.	31.1
6	12	5 1/4 x 19 1/2	102.	3,244.	333.	24.2
14	8	12 1/2 x 13	163.	2,289.	352.	38.4
6	13	5 x 21 3/8	106.	3,928.	372.	24.9
8	11	7 x 17 3/8	125.	3,332.	373.	29.5
6	13	5 1/4 x 21 3/8	111.	4,124.	390.	26.2
12	9	11 x 14 7/8	161.	2,867.	392.	38.0
10	10	9 x 16 1/4	146.	3,218.	396.	34.5
6	14	5 x 22 3/4	114.	4,906.	431.	26.9
8	12	7 x 19 1/2	137.	4,325.	444.	32.2
14	9	12 1/2 x 14 7/8	183.	3,258.	446.	43.1
6	14	5 1/4 x 22 3/4	119.	5,151.	453.	28.2
10	11	9 x 17 3/8	161.	4,284.	479.	38.0
12	10	11 x 16 1/4	179.	3,933.	484.	42.2
6	15	5 x 24 3/8	122.	6,034.	495.	28.8
16	9	14 1/2 x 14 7/8	212.	3,780.	517.	50.1
6	15	5 1/4 x 24 3/8	128.	6,336.	520.	30.2
8	13	7 x 21 3/8	148.	5,499.	521.	34.9
14	10	12 1/2 x 16 1/4	203.	4,470.	550.	47.9
6	16	5 x 26	130.	7,323.	563.	30.7
10	12	9 x 19 1/2	176.	5,561.	570.	41.4
12	11	11 x 17 3/8	197.	5,235.	586.	46.2
6	16	5 1/4 x 26	137.	7,690.	592.	32.2
8	14	7 x 22 3/4	159.	6,868.	604.	37.6
16	10	14 1/2 x 16 1/4	236.	5,185.	638.	55.6
14	11	12 1/2 x 17 3/8	223.	5,949.	666.	52.7
10	13	9 x 21 3/8	190.	7,071.	669.	44.9
8	15	7 x 24 3/8	171.	8,448.	693.	40.3
12	12	11 x 19 1/2	215.	6,797.	677.	50.6
16	11	14 1/2 x 17 3/8	259.	6,901.	772.	61.2
10	14	9 x 22 3/4	205.	8,831.	776.	48.3

Nominal Width in Inches	Number of 1 5/8" Laminations*	Net Finished Size* b in Inches h in Inches	Area of Section in Square Inches	Moment of Inertia $I = \frac{bh^3}{12}$	Section Modulus $S = \frac{bh^2}{6}$	Weight in Pounds per Linear Foot at 12% Moisture Content
8	16	7 x 26	182.	10,250.	789.	43.0
14	12	12 1/2 x 19 1/2	244.	7,724.	792.	57.5
12	13	11 x 21 3/8	232.	8,642.	818.	54.8
8	17	7 x 27 3/8	193.	12,300.	890.	45.6
10	15	9 x 24 3/8	219.	10,860.	891.	51.8
16	12	14 1/2 x 19 1/2	283.	8,960.	919.	66.7
14	13	12 1/2 x 21 3/8	264.	9,820.	930.	62.3
12	14	11 x 22 3/4	250.	10,790.	949.	59.1
8	18	7 x 29 1/4	205.	14,600.	998.	48.3
10	16	9 x 26	234.	13,180.	1,014.	55.2
14	14	12 1/2 x 22 3/4	284.	12,270.	1,078.	67.1
16	13	14 1/2 x 21 3/8	306.	11,390.	1,078.	72.3
12	15	11 x 24 3/8	268.	13,280.	1,089.	63.3
8	19	7 x 30 7/8	216.	17,170.	1,112.	51.0
10	17	9 x 27 3/8	249.	15,810.	1,145.	58.7
8	20	7 x 32 1/2	228.	20,030.	1,232.	53.7
14	15	12 1/2 x 24 3/8	305.	15,090.	1,238.	71.9
12	16	11 x 26	286.	16,110.	1,239.	67.5
16	14	14 1/2 x 22 3/4	330.	14,230.	1,251.	77.9
10	18	9 x 29 1/4	263.	18,770.	1,283.	62.1
8	21	7 x 34 1/8	239.	23,180.	1,359.	56.4
12	17	11 x 27 3/8	304.	19,320.	1,399.	71.7
14	16	12 1/2 x 26	325.	18,310.	1,408.	76.7
10	19	9 x 30 7/8	278.	22,070.	1,430.	65.6
16	15	14 1/2 x 24 3/8	353.	17,500.	1,436.	83.4
8	22	7 x 35 3/4	250.	26,650.	1,491.	59.1
12	18	11 x 29 1/4	322.	22,940.	1,569.	75.9
10	20	9 x 32 1/2	293.	25,750.	1,584.	69.0
14	17	12 1/2 x 27 3/8	345.	21,960.	1,590.	81.5
16	16	14 1/2 x 26	377.	21,240.	1,634.	89.0
10	21	9 x 34 1/8	307.	29,800.	1,747.	72.5
12	19	11 x 30 7/8	340.	26,980.	1,748.	80.2
14	18	12 1/2 x 29 1/4	366.	26,070.	1,782.	86.3
16	17	14 1/2 x 27 3/8	401.	25,470.	1,844.	94.5
10	22	9 x 35 3/4	322.	34,270.	1,917.	75.9
12	20	11 x 32 1/2	358.	31,470.	1,936.	84.4
14	19	12 1/2 x 30 7/8	386.	30,660.	1,986.	91.1
16	18	14 1/2 x 29 1/4	424.	30,240.	2,068.	100.
10	23	9 x 37 3/8	336.	39,160.	2,095.	79.4
12	21	11 x 34 1/8	375.	36,430.	2,135.	88.6
14	20	12 1/2 x 32 1/2	406.	35,760.	2,201.	95.9
10	24	9 x 39	351.	44,490.	2,282.	82.8
16	19	14 1/2 x 30 7/8	448.	35,560.	2,304.	106.
12	22	11 x 35 3/4	393.	41,880.	2,343.	92.8
14	21	12 1/2 x 34 1/8	427.	41,390.	2,426.	101.
10	25	9 x 40 7/8	366.	50,290.	2,476.	86.3
16	20	14 1/2 x 32 1/2	471.	41,480.	2,553.	111.
12	23	11 x 37 3/8	411.	47,860.	2,561.	97.0
14	22	12 1/2 x 35 3/4	447.	47,590.	2,663.	105.
10	26	9 x 42 1/4	380.	56,560.	2,678.	89.7
12	24	11 x 39	429.	54,380.	2,789.	101.
16	21	14 1/2 x 34 1/8	495.	48,020.	2,814.	117.
10	27	9 x 43 7/8	395.	63,350.	2,888.	93.2
14	23	12 1/2 x 37 3/8	467.	54,380.	2,910.	110.
12	25	11 x 40 7/8	447.	61,460.	3,026.	105.
16	22	14 1/2 x 35 3/4	518.	55,210.	3,089.	122.
10	28	9 x 45 1/2	410.	70,650.	3,105.	96.6
14	24	12 1/2 x 39	488.	61,790.	3,169.	115.
12	26	11 x 42 1/4	465.	69,130.	3,273.	110.
16	23	14 1/2 x 37 3/8	542.	63,090.	3,376.	128.
14	25	12 1/2 x 40 3/8	508.	69,840.	3,438.	120.
12	27	11 x 43 7/8	483.	77,420.	3,529.	114.
16	24	14 1/2 x 39	566.	71,680.	3,676.	133.
14	26	12 1/2 x 42 1/4	528.	78,560.	3,719.	125.
12	28	11 x 45 1/2	501.	86,350.	3,795.	118.
16	25	14 1/2 x 40 3/8	589.	81,020.	3,988.	139.
14	27	12 1/2 x 43 7/8	548.	87,980.	4,010.	129.
12	29	11 x 47 1/8	518.	95,930.	4,071.	122.
14	28	12 1/2 x 45 1/2	569.	98,120.	4,313.	134.
16	26	14 1/2 x 42 1/4	613.	91,130.	4,314.	145.
12	30	11 x 48 3/4	536.	106,200.	4,357.	127.
14	29	12 1/2 x 47 1/8	589.	109,010.	4,627.	139.
12	31	11 x 50 3/8	554.	117,180.	4,652.	131.
16	27	14 1/2 x 43 7/8	636.	102,060.	4,652.	150.
14	30	12 1/2 x 48 3/4	609.	120,680.	4,951.	144.
16	28	14 1/2 x 45 1/2	660.	113,820.	5,003.	156.
14	31	12 1/2 x 50 3/8	630.	133,160.	5,287.	149.
16	29	14 1/2 x 47 1/8	683.	126,460.	5,367.	161.
16	30	14 1/2 x 48 3/4	707.	139,990.	5,743.	167.
16	31	14 1/2 x 50 3/8	730.	154,470.	6,133.	172.

* With glued laminated structural lumber, many additional sizes may be obtained. Greatest economy will result by using standard widths and depths that are multiples of standard board and dimension lumber thicknesses.

